

REMARKS/ARGUMENTS

Claims 1 to 20 are currently pending in this application. Claims 1 and 2 have been amended and claims 21 and 22 have been added. No new matter has been added with this response.

Rejections Under 35 U.S.C. §103(a)

The Examiner rejected all of the pending claims as unpatentable under 35 U.S.C. §103(a) over either Odagawa et al. (USPN 5,647,921) or Arakawa et al. (USPN 4,768,458). Applicants respectfully traverse this rejection.

The current invention is directed to an improved process for producing thick continuous sheet sections of amorphous metal. To accomplish this Applicants have modified conventional continuous sheet casting processes to include a stabilization step so that the exact viscosity of the liquid alloy can be controlled prior to introduction onto the sheet casting roller. As described in the background of the specification, this viscosity stabilization runs counter to conventional practice, which has focused entirely on the mechanics of the casting process such as roller speed, slit size, slit geometry, cooling rate, etc. [Specification, pages 1 to 2.] Moreover, Applicants also specifically explain that were one to attempt to form the thick sheet sections of the current invention using such a conventional processes the lack of control over the viscosity would lead to unstable casting resulting in discontinuities in the sheet. For example, Applicants write:

Although it is possible to obtain quench rates at lower velocities, there are many difficulties encountered. For example, at typical melt viscosities and low wheel rotational speed it is not possible to reliably sustain a continuous process. As a result, the melt may flow too fast through the orifice slit and spill over the wheel, precluding a stable melt puddle and a steady state moving solidification front. Although, some remedies can be

implemented, such as reducing the orifice slit size, generally this is not a practical solution because the molten metal would erode the opening of such a small orifice very quickly. [Specification, page 2, lines 13 to 20.]

As discussed in the specification of the instant application, as a result conventional continuous casting processes address these issues by keeping the thickness of the sheet below 100 μm . [See, e.g., Specification, page 2, lines 20 to 24.] This conventional response to the problems associated with the continuous casting of amorphous materials is echoed in the very prior art cited by the Examiner. For example, Odagawa et al. recite twenty-three separate examples of exemplary amorphous alloy ribbons the thickest of which is 39 μm . In addition, as discussed above, Odagawa et al. never disclose or even suggest a step of stabilizing the molten alloy, either around or below the melting temperature, before casting to ensure a viscosity between 0.1 and 1,0000 poise as required by the current application. [Support for these limitations may be found in the Specification, paragraphs 37 to 40.] Indeed, as Applicants describe in the background of their specification, Odagawa et al. only describe modifications to the mechanics of introducing the molten metal onto the sheet roller. For example, Odagawa et al. in discussing the process of the '921 patent never describe preferred viscosity levels, but rather describe the surface velocity of the rotating wheel, the injection pressure of the molten alloy, the casting temperature, the slot width at the nozzle tip and the gap between the nozzle tip and the cooling wheel. [See, e.g., Odagawa et al, col. 3, lines 1 to 60; and cols. 4 and 5.]

The Arakawa et al. patent likewise relies solely on the conventional understanding of continuous sheet casting that Applicants teach against. For example, like in the Odagawa et al. patent, Arakawa et al. teach only the production of thin ribbons of amorphous alloy having thicknesses no greater than 0.05 mm. Moreover,

Arakawa et al. specifically teach that the method disclosed in their patents is preferred for use with very thin sheets of amorphous alloy, stating:

In the present invention, the restriction of the front lip width W_f as $W_f/W \leq 0.8$ makes the upper surface of the melt puddle rather free and makes the surface conditions of the metal sheet excellent. The top surface roughness R_z (by JIS B0 601-1970) can be improved. Especially the improvement of the top surface conditions for a rather thin metal ribbon having a thickness of 25 μm or less is remarkable. (Arakawa et al., col. 3, lines 13 to 21.)

Indeed, the background of the Arakawa et al. patent seems to suggest that the process is focused, not on forming thick ribbons, but on improving the process of making very thin ribbons, stating in relevant part:

However, in the above-mentioned processes, three were drawbacks that the produced [sic] amorphous metal ribbon, especially a ribbon having a thickness of about 25 μm or less might be provided with scratches on the surface or with a rough surface. (Arakawa et al., col. 1, lines 60 to 64.)

In addition, as in the Odagawa et al. patent, Arakawa et al. never teach a step of stabilizing the viscosity of the molten amorphous material to ensure better casting and the availability of thicker sheets. Indeed, Arakawa et al., like the authors of Odagawa et al., never even suggest that the viscosity of the molten alloy could be manipulated. Instead the Arakawa et al. patent is again focused on forming very well defined thin ribbons of amorphous alloy by controlling the speed of the roller, the geometry of the nozzle, and its relationship to the cold roller.

In short, neither Odagawa et al. nor Arakawa et al. ever teach, disclose or even suggest a step of "stabilizing" the molten amorphous alloy to ensure a specific viscosity prior to the casting. The Examiner seems to dismiss this serious deficiency by stating,

without evidence, that one of ordinary skill in the art would have been motivated to stabilize the amorphous metal to ensure a viscosity that would allow successful casting. However, both Odagawa et al. and Arakawa et al., focused as they are with adjusting the roller speed and nozzle alignment to ensure appropriate sheet casting, teach precisely the type of conventional casting techniques that the current invention was designed to address. Applicants submit that one of skill in the art, having read either or both the Odagawa et al. and/or the Arakawa et al. references, would not have had any motivation to include a viscosity stabilization step as required by the claims of the current application, much less a motivation as to what range of viscosity should be used in the process, but rather would have been motivated to attempt changes to the roller speed, nozzle width, nozzle gap, etc.. Indeed, as Arakawa et al. and Odagawa et al. both teach similar solutions, Applicants believe the combination of the cited references would have reinforced the need to resort to such manipulations, leading one of ordinary skill further away from Applicants own casting technique.

In summary, given the process parameters repeatedly taught by cited prior art, one of skill in the art would have had no motivation to modify those same references to produce the method claimed in the current application. Accordingly, Applicants submit that the claimed invention cannot be said to be obvious in light of the Odagawa et al. and/or Arakawa et al. references.

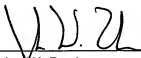
Conclusion

In view of the foregoing amendment and response, it is believed that the application is in condition for further examination. If any questions remain regarding the allowability of the application, Applicant would appreciate if the Examiner would advise the undersigned by telephone.

Respectfully submitted,

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